

Economics 101  
Fall 2014  
Homework #5  
Due Thursday, Dec 11, 2014

**Directions:** The homework will be collected in a box **before** the lecture. Please place your name, TA name and section number on top of the homework (legibly). Make sure you write your name as it appears on your ID so that you can receive the correct grade. Late homework will not be accepted so make plans ahead of time. **Please show your work.** Good luck!

**Please realize that you are essentially creating “your brand” when you submit this homework. Do you want your homework to convey that you are competent, careful, and professional? Or, do you want to convey the image that you are careless, sloppy, and less than professional. For the rest of your life you will be creating your brand: please think about what you are saying about yourself when you do any work for someone else!**

### 1. Monopoly

Suppose Steepery Tea Bar is a monopolist in producing bubble teas in Madison. The market demand curve for bubble teas faced by this monopolist is given as  $P = 10 - (1/8)Q^D$ . The tea bar's total cost is given by  $TC = (1/32)Q^2 + 32$  and the marginal cost is given by  $MC = (1/16)Q$ . Use this information to answer the following questions.

- What is the equation for the marginal revenue (MR) curve for Steepery Tea Bar?
- What are the equations for the average total cost (ATC) and average variable cost (AVC)?
- What is the profit maximizing production quantity  $Q_M$  for Steepery Tea Bar if the monopolist only charges one price? What price  $P_M$  will it charge? Calculate the value of this monopolist's profits?
- Compute the consumer surplus and producer surplus for the monopolist.
- Now suppose there is a new juice bar, Jamba Juice, that opens across the street from Steepery Tea Bar. Though it does not provide bubble teas, the juices and smoothies Jamba Juice makes are alternatives to bubble teas. Therefore, the demand for bubble teas decreases by 20 cups at every given price. Write down the equation for Steepery Tea Bar's new demand curve. Then, calculate the new profit maximizing production quantity  $Q'_M$  and price  $P'_M$  for Steepery Tea Bar. Calculate the monopolist's new profit. Assume the monopolist only charges one price.

f. Now, suppose the fixed cost for Steepery Tea Bar decreases to \$20 when the equipment needed to produce bubble tea gets cheaper. Given this information, what is the equation for the new TC curve for Steepery Tea Bar? Calculate the new profit maximizing production quantity, price, and profit for Steepery Tea Bar given the new TC curve and the demand curve in e).

## 2. Natural Monopoly

Comcast is a natural monopoly for cable TV and internet in C'ville. Suppose the following information about Comcast operations is true.

$$\text{Marginal Revenue} = 100 - 20Q$$

$$\text{Total Cost} = 100 + 12Q + Q^2$$

$$\text{Marginal Cost} = 12 + 2Q$$

- Find the equation for the average total cost (ATC) of Comcast.
- Using the equation you got from part (a) to fill in the below table.

Quantity	ATC
1	
2	
4	
5	
10	

- Based on your calculations in part (b), does Comcast experience economies of scale when the quantity is below 10?
- Assume the market demand function faced by Comcast is linear. Given the above information, what is the equation for the market demand curve?
- Suppose now that there is no government regulation whatsoever. If there is no regulation, what the price and quantity will Comcast choose? Is this the socially optimal quantity and price? Explain your answer. (*Hint: we identify the socially optimal amount of the good as being that amount of the good where the price the consumer pays for the last unit of the good is exactly equal to the marginal cost of producing that last unit of the good.*)

f. Now suppose the government imposes the regulation that Comcast must produce the socially optimal amount of output. What quantity will Comcast produce and what price will it charge given this type of regulation?

g. Based on (f), is there a need for a subsidy to keep Comcast in business under this regulation? If yes, what must the natural monopoly receive from the government in order to be willing to produce the socially optimal amount of the good? (*Hint*: calculate the profit of Comcast under part (f).)

h. Calculate Comcast's consumer surplus (CS) and producer surplus (PS) under part (e). Is there any deadweight loss (DWL)? If yes, how much is DWL?

### 3. Price Discrimination

Suppose that there are three groups of people who take buses to commute in Richmond, VA. The first group is students, the second group is professors, and the third group is professionals. The demand for each group is given by the following equations:

$$\text{Demand of students: } P = 8 - (1/2)Q_s$$

$$\text{Demand of professors: } P = 16 - 2Q_{\text{prof}}$$

$$\text{Demand of professionals: } P = 20 - Q_{\text{pro}}$$

The city bus company has constant marginal cost at  $MC = \$4$ , and total cost at  $TC = 4Q + 10$ .

a. Assume that the bus company can perfectly distinguish people's identities as students, professors, or professionals. This means that the bus company can charge different people different prices based upon which group they belong to. Calculate the quantity of bus rides that students will buy and the price they will pay per bus ride.

b. Continuing with the assumptions that we had in part (a), calculate the quantity of bus rides that professors will buy and the price they will pay per bus ride.

c. Continuing with the assumptions that we had in part (a), calculate the quantity of bus rides that professionals will buy and the price they will pay per bus ride.

d. Given the quantities and prices you have calculated in parts (a) through (c), what is the value of total profit for the bus company when it sells bus tickets to students, professors, and professionals? That is, calculate the value of this company's profits when it charges different prices to each of the groups it serves and produces different quantities of the good for each of the groups.

e. Now for the sake of comparison let's assume that the bus company cannot distinguish people's group identities perfectly. The only thing the bus company can do is to check whether the passenger is a student or not. Given this information, what

would be the bus company's optimal pricing strategy now? You need to find specific prices and quantities.

f. Calculate the total profit in part (e) when the bus company charges one price and quantity pair to students and another price and quantity pair to the other consumers in the market for bus rides. How does this new level of profits compare to the level of profits you calculated in (d)?

#### 4. Game Theory

Nicky and Kendrick are musicians who each want to play a huge concert for their group of friends on New Year's Day. Nicky knows that Kendrick wants to have his own concert, and Kendrick knows that Nicky wants her own concert. The problem is that if they both have a concert at the same time, half their friends will go to each, and neither of them wants a half-full concert.

Here is the payoff matrix providing a measure of the benefits that Nicky and Kendrick each receive depending upon whether they play a concert or not. In each cell the first number refers to Nicky's benefit while the second number refers to Kendrick's benefit.

		Kendrick	
		No Concert	Concert
Nicky	No Concert	0, 0	-5, 10
	Concert	10, -5	-10, -10

- Is there any strictly dominant strategy for Nicky?
- Is there any strictly dominant strategy for Kendrick?
- Is there an equilibrium outcome that we can predict for this game?

Kendrick decides that rather than having a huge concert in a big arena, he could instead hold his concert in a small neighborhood theater. With this new venue choice, the new payoff matrix is given below.

		Kendrick	
		No Concert	Concert
Nicky	No Concert	0, 0	-5, 7
	Concert	10, -5	-10, 7

- d. With the new payoffs, is there a dominant strategy for Kendrick?
- e. What outcome can we predict for this game now?

### 5. Public Goods

Consider a community that has two residents, Leslie and Ron. Leslie and Ron would both like to have some public parks in their community and they are trying to decide on the optimal number of parks to build, and what price they should each contribute for each park. Luckily they are both willing to reveal their preferences and so we do not have to worry about the free rider problem. Leslie's demand for parks is given by the equation  $Q = 6 - 2P$  and Ron's demand for parks is given by the equation  $P = 3/2 - (1/4)Q$ . The marginal cost of providing a park is \$3.

- a. On your homework paper draw three graphs vertically one above the other. The first graph should be labeled "Leslie's demand"; the second graph should be labeled "Ron's demand"; and the third graph should be labeled "Market demand". On each graph the horizontal axis should be labeled "Quantity of Parks" while the vertical axis should be labeled "Price of Parks". Now in each graph draw in the demand curve corresponding to your label. Remember that the market demand curve will be a vertical summation of the individual demand curves since a public good is non-rival.
- b. Write an equation for the market demand curve for the public good.
- c. What is the optimal number of parks for the community? Show how you found this number.
- d. Since Leslie and Ron each get benefits from the parks, they will each contribute towards the cost. Given her demand, how much will Leslie contribute per park? How much will Ron contribute per park? Why do Leslie and Ron contribute different amounts?
- e. Now think about what would happen if Leslie and Ron were unable to share the same parks. Now each of them would have to build their own private park, and pay the full cost. How many parks are Leslie and Ron willing to pay for individually? How many total parks would be built? (*Remember: we can't build negative parks.*)

## 6. Externalities

For this problem, we want to think about the market for greenhouse gas emissions, which are a byproduct of burning fossil fuels. The suppliers of greenhouse gas emissions include companies that produce electricity, as well as everyone who drives in cars, flies in airplanes, etc. These uses of energy provide a marginal private benefit (MPB) to consumers, since we value being able to turn on the lights and travel. These energy sources have a marginal private cost (MPC) as well, since we must purchase the gasoline and coal used in our cars, airplanes, and power plants. We can write these marginal cost and benefit curves as equations that depend on  $Q$ , the quantity of greenhouse gas emissions:

$$\text{MPB} = 200 - Q$$

$$\text{MPC} = Q$$

The production of these emissions also causes changes to the atmosphere, which imposes some external costs on society as a whole, as people make costly adjustments to the changing climate. Let's say these external costs are estimated to be \$20 per unit of greenhouse gas emissions. This external cost is currently not being internalized in the market.

- a. Given the MPB and MPC curves, what is the market quantity of emissions  $Q$  that will be produced?
- b. Is the current level of market production of emissions the socially optimal amount? Explain your answer.
- c. What are the values of consumer surplus (CS), producer surplus (PS), and the external costs given the current level of emission production? Calculate Total Surplus as  $(\text{CS} + \text{PS} - \text{external costs})$ . Draw a graph illustrating each of these concepts in the market for greenhouse gas emissions.
- d. The marginal cost to society, or the marginal social cost (MSC), as a whole from producing emissions is the sum of MPC and the marginal external cost. Write down the equation for Marginal Social Cost,  $\text{MSC} = \text{MPC} + \text{marginal external cost}$ , and draw it on a graph with MPC and MSB. What is the socially optimal quantity of emissions? (*Note that because there is no external benefit from producing emissions,  $\text{MPB} = \text{MSB}$ .*)
- e. Your graph should now include MPC, MSC, and  $\text{MPB} = \text{MSB}$ . The graph should look familiar to you! It resembles a market with an excise tax. What per-unit tax would the government have to put on each unit of greenhouse gas emissions in order for the market equilibrium quantity of emissions to equal the socially optimal quantity?